View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by CiteSeerX

Proceedings of IPC'02
4th International Pipeline Conference
September 29-October 3, 2002, Calgary, Alberta, Canada

IPC2002-27251

MANAGEMENT SYSTEM AUDITS: A PATH TOWARDS SAFER PIPELINES

Lawrence Ator, E.I.T.
National Energy Board
Calgary, Alberta

Minh Ho, E.I.T.
National Energy Board
Calgary, Alberta

ABSTRACT

The National Energy Board of Canada (NEB), a federal energy regulator, has implemented a management system audit program as a tool to verify compliance with its predominantly goal-oriented *Onshore Pipeline Regulations, 1999* (*OPR*) [1]. The *OPR* allow individual companies to choose the most effective way to manage their pipeline systems. The audit program is based on expected elements that the NEB believes are necessary to meet the goals of the *OPR*.

This paper will explain why these audits and expected elements are necessary and describe how goal-oriented regulations will enhance pipeline safety. The audits conducted to date have identified several challenges that the NEB and pipeline companies face in pursuit of the goal of safe pipelines; these will be described and possible solutions will be proposed. The overall objective of the paper is to explain the benefits of using a management system approach to direct a company's pipeline integrity management program and what is required of companies to meet the expectations of the NEB.

BACKGROUND

One of the NEB's four goals is to ensure that its regulated facilities are safe and perceived to be safe. One means of achieving this goal is the promulgation of the *Onshore Pipeline Regulations, 1999* (*OPR)* [1]. These Regulations, which came into effect on August 1, 1999 after extensive consultation with stakeholders, are a step towards goal-oriented regulation. Goal-oriented regulation requires pipeline companies to meet regulatory goals, as opposed to prescriptive regulation which requires pipeline companies to perform imposed actions.

The *OPR* contain both prescriptive and goal-oriented elements. The requirement for pipelines to follow the Canadian Standards Association (CSA) *Z662* [2] is the main prescriptive element of the *OPR*. For a pipeline to be perceived to be safe it must meet the level of safety that the Canadian public expects; in the view of the NEB, *CSA Z662* provides a minimum level of safety. This means that the NEB expects its regulated companies to provide at least the level of safety that the prescriptive elements of *CSA Z662* provide in all of their pipeline activities, even those not specifically addressed by *CSA Z662*. The goal-oriented part of the *OPR*, specifically the requirement for companies to "develop a pipeline integrity management program" (IMP) under section 40, is intended to assure that companies consistently apply at least this level of safety to their pipeline system operations.

Section 40 of the *OPR* is supplemented by guidance notes. The guidance notes are not regulations; they are suggestions to companies about how they could demonstrate to the NEB that their facilities and operations meet the standard of safety.

WHY MANAGEMENT SYSTEM AUDITS?

For pipeline companies to meet section 40 of the *OPR*, they must conduct activities that identify, assess, and mitigate hazards. These activities must be adequate to meet their purpose and must be carried out effectively.

Consistency, self-evaluation, and documentation are necessary to ensure that activities related to the IMP are adequate and effective across the pipeline system. As required by the *OPR*, a company must periodically evaluate the adequacy and effectiveness of its IMP. This evaluation is possible only if there is documentation of the intent of each applicable activity, a procedure or description of the activity, qualifications required to perform the activity, and a record of the activity.

Most NEB-regulated pipeline systems are extensive and may be affected by a variety of hazards. This means that many employees with diverse backgrounds, working from geographically remote locations, must be involved in the execution of IMP-related activities. Procedures and training are necessary to ensure these employees carry out their duties in a consistent manner. Therefore, a company needs documented

Copyright © 2002 by ASME

Downloaded From: https://proceedings.asmedigitalcollection.asme.org on 06/29/2019 Terms of Use: http://www.asme.org/about-asme/terms-of-use

procedures, training requirements, and evaluation processes to be in compliance with the *OPR* and to ensure that pipeline integrity is maintained. The NEB conducts management system audits of its regulated companies to verify that they have this effective documented management system.

For the prescriptive component of its regulations, the NEB uses construction and facility inspections to verify that specific activities are conducted in a specified manner at individual sites. For the goal-oriented component of its regulations, the NEB verifies that companies are employing a comprehensive strategy across their business to ensure that their pipelines are safe. This verification requires a top-down view in addition to the bottom-up perspective of inspections.

AUDIT PROGRAM IMPLEMENTATION

To facilitate the implementation of its audit program, the NEB conducted four gap analyses between February and July 2000. These were "pilot audits" conducted with NEB regulated companies to give the NEB and the participating companies an idea of the obstacles facing the industry in moving towards a management system approach. The gap analyses also introduced the NEB to the process of conducting management system audits and identified obstacles facing the NEB in the implementation of goal-oriented regulations.

The main issues for the NEB were a need for competent auditors, a need to focus on management systems as opposed to operational details, and a need for consistent acceptance criteria. To address the first two issues, the NEB formed an audit team with members from a range of backgrounds and disciplines. This team was and continues to be trained in the methods of management system auditing. To address the third issue, the NEB has developed a set of elements it believes are necessary to achieve the goal of pipeline safety. These Expected Elements provide auditors with a guideline for the level of safety that the NEB expects for all aspects of the design, construction, operation, and abandonment of pipeline facilities. They are not meant as a document telling companies how to comply with the *OPR*. In order for the Expected Elements to fulfill their purpose of providing auditors a "measuring stick" to gauge the level of safety of a company, they contain more practices than the NEB might necessarily expect any individual company to implement.

The NEB sends the Expected Elements to a company prior to the audit. The intent is not for a company to change its practices to conform to those described in the Expected Elements. However, a company must ensure that its practices deal with any relevant issues addressed by the Expected Elements. If any issue is not applicable to the company, the NEB does not expect the company to implement any practices to deal with that issue. If a given issue does apply and the company is dealing with it in a way not described in the Expected Elements, the company needs to be able to explain the rationale for its practices. The NEB will accept any practice that provides an acceptable level of safety and may revise the Expected Elements to reflect new practices. In this way, the Expected Elements are an evolving, living document.

NEB EXPECTATIONS OF AN IMP

The NEB expects a company's IMP to be comprehensive, proactive, flexible, and continually improved (i.e., process approach). Maintaining pipeline integrity should be a "cradle-to-grave" objective. Pipeline integrity must start at the design stage and must not finish until abandonment has been completed. An IMP must anticipate and resolve potential issues before they become problems. An IMP must also be evaluated regularly to determine what measures can be taken to improve the program with finite human and financial resources.

The following ten elements encapsulate the NEB's expectations of an IMP:

Pipeline Integrity Policy and Program Scope

The NEB expects a company to direct its IMP in a manner not unlike the way it manages its overall business. That is, the NEB expects top management to define and periodically review a pipeline integrity policy to ensure it appropriately deals with safety, environmental, and reliability risks. The policy should dictate the program scope. The NEB expects the scope to cover the entire pipeline system under the NEB's jurisdiction. If a company chooses to address the integrity of its aboveground facilities in a separate program, the IMP is expected to state this exclusion.

Organizational Responsibilities

Once the policy and scope of the IMP have been defined, the NEB expects a company to assign personnel who would be accountable or responsible for developing and implementing the various components of the IMP. At the same time, the NEB expects a company to allocate appropriate resources for the IMP. In recent years, the public has expected companies and regulators to provide more assurance of pipeline safety and environmental protection.

Recognizing the finite financial resources of companies in a competitive market, the NEB expects a company to implement a strategy whereby resources are dedicated to effectively manage risks without sacrificing employee and public safety, environmental protection, and reliability. As will be noted, the ability of a company to manage risks effectively will be greatly enhanced if it has developed and maintained a system for the collection and integration of relevant data.

Personnel Competency

Once personnel have been assigned responsibilities for the development and implementation of the IMP, the NEB expects a company to develop a system to ensure that all the personnel are competent (i.e., knowledgeable and skilled based on acquired education and training) and remain competent (e.g., via refresher training) in performing various procedures. A competency program should be documented and should also ensure that personnel are kept abreast of new research,

Copyright © 2002 by ASME

Downloaded From: https://proceedings.asmedigitalcollection.asme.org on 06/29/2019 Terms of Use: http://www.asme.org/about-asme/terms-of-use

technology, and/or acceptable industry practices and standards. This aspect is related to a company's change management program, which is discussed later in this paper. The NEB expects a company to measure the effectiveness of the competency program for its employees and to make any required adjustments.

Contractor Evaluation, Selection, and Management

The NEB recognizes that many companies obtain the services of contractors for a variety of pipeline (including aboveground facilities) maintenance activities. Companies also contract consultants with specialized or expert knowledge and services. The NEB expects companies to develop qualification criteria for evaluating and selecting appropriate contractors and consultants. In addition, the NEB expects companies to have a system for managing contractors to ensure that they do not jeopardize the integrity of the pipeline system while they are in the process of maintaining or enhancing pipeline integrity. As well, the NEB expects companies to have a process for evaluating, implementing, and documenting any recommendations provided by consultants.

Risk Assessment

A company is expected to conduct a risk assessment of its pipeline system. As defined by *CSA Z662*, risk assessment is "the process of risk analysis and risk evaluation". Risk analysis, in turn, requires an identification of potential hazards and an estimation of the risks associated with one or more of the hazards (e.g., corrosion, environmentally assisted cracking, third-party damage, geo-technical issues). A company should examine its history of near misses and incidents, results of inspections and operation and maintenance (O&M) activities, and industry statistics for assistance in identifying actual and potential hazards to its pipeline system. Appendix B of *CSA Z662* provides guidelines for pipeline risk assessment, including different methods that can be used for hazard identification and risk estimation. The NEB expects a documented and rational risk assessment that would be used by a company to develop and maintain its IMP.

Condition Monitoring Program

Once a company has identified and assessed risks to its pipeline system, the NEB expects a company to develop a program either to monitor for conditions that may jeopardize mechanical integrity or to mitigate such conditions. Condition monitoring can be conducted via many different methods. These include ground/aerial patrol, leak detection system, in-line inspection (ILI), pressure testing, and direct assessment methods.

The NEB neither stipulates the methods that companies must use to monitor the conditions of its pipeline system nor the frequencies by which the methods must be carried out. However, the NEB expects companies to choose suitable methods and frequencies based on established criteria, with a full understanding of their capabilities and limitations, to provide the appropriate information about the integrity of its pipeline system. If a company encounters conditions where the current best technology is either not available or not capable (e.g., no ILI tool for detecting hook cracks along an electric resistance welded seam on smaller diameter pipelines), the NEB expects a company to determine the extent of the problem along its pipeline system using alternative methods. The NEB may encourage the company, in this example, to fund the research and development of a tool that would provide it with a clearer understanding of the susceptibility or the presence of such defects in the pipeline system.

In addition to having documented procedures for various condition-monitoring activities, the NEB expects a company to develop acceptance criteria for evaluating anomalies or imperfections that may be found.

Mitigation Program

An IMP is expected to include a mitigation program to prevent pipeline failures (i.e., leaks or ruptures) or to minimize adverse consequences if a pipeline failure were to occur. Table 10-1 of *CSA Z662* requires a company to use only acceptable pipeline repair methods for specific defects. The NEB expects a company to develop appropriate criteria for establishing repair priorities and documented procedures, whether written by staff or by contractors, for each repair method. The NEB also expects the personnel who carry out the mitigation activity to be competent to ensure that company expectations and regulatory requirements are met.

In addition, the NEB expects a company's mitigation program to include a process and/or procedure for investigating incidents (including near misses) to determine underlying causes so that measures can be identified and implemented to prevent occurrences or to avoid recurrences.

Management of Change

Change is constant in the pipeline industry. A company may confront changes in regulations (e.g., *OPR*), industry practices and standards (e.g., *CSA Z662*), facilities and operations, technology, procedures, and/or personnel. Some of these changes may arise out of a company's IMP and some may affect the IMP.

The *OPR* require a company to develop and apply a program to monitor and manage such changes. The NEB has provided guidance to companies for developing a management of change (MOC) program. In general, the program should include procedures for identifying changes; methods to assess any hazards associated with the proposed changes; and a process for approving, implementing, communicating, and documenting the changes. Once developed and implemented, the NEB expects a company to evaluate its MOC program to ensure that it is adequate to maintain pipeline integrity so as to protect employee and public safety and the environment.

Record Handling System

Copyright © 2002 by ASME

Downloaded From: https://proceedings.asmedigitalcollection.asme.org on 06/29/2019 Terms of Use: http://www.asme.org/about-asme/terms-of-use

Both the *OPR* and *CSA Z662* require companies to maintain various design, construction, O&M, and abandonment records. Beyond compliance, the NEB expects companies to develop a record handling system to demonstrate due diligence and the adequacy and effectiveness of its programs in ensuring the safety of persons and the protection of the environment and property throughout the cradle-to-grave cycle of a pipeline system. The *OPR* provide guidance to what should be included in a record handling system. In short, the NEB expects a record handling system to outline what, when, and how appropriate records are to be created, stored, retrieved, modified, and removed (when no longer valid) in a timely manner.

The NEB does not stipulate the type of medium, platform, or software package that companies must use to manage its corporate data. As with other components of the IMP, the onus is on a company to develop a system that meets its needs, that is used by its personnel, and that allows it to make informed decisions to maintain the integrity and reliability of its pipeline system.

Program Evaluation

On a regular periodic basis, the NEB expects a company to evaluate the adequacy and effectiveness of its IMP. This evaluation is not unlike the periodic reviews that top management conducts to determine whether the company is meeting established corporate goals and objectives and whether any changes are needed. A company must be able to demonstrate that it has devoted appropriate resources and has utilized qualified personnel and procedures to manage the integrity of its pipeline system.

The *OPR* require a company to conduct regular audits of its programs. Audits, whether internal or external, are only one method of measuring or evaluating the adequacy and effectiveness of the IMP. *API Standard 1160* [3] provides some guidelines for measuring performance using leading and lagging indicators. The NEB also expects companies to track safety and environmental performance indicators [4].

In the final analysis, the onus is on a company to provide a rationale for the method(s) it uses to measure the adequacy and effectiveness of all the expected elements and components of its IMP. The NEB expects that program evaluation is performed – for safety, environmental, reliability, and business reasons.

GENERAL IMP AUDIT FINDINGS

In 2001, the NEB evaluated the IMP of six pipeline companies. The audit process has found the following five general areas where companies have failed to meet the expectations of the NEB. These areas are not an exclusive list of issues that were found but they cover those issues that were present in most of the audited companies. They are listed in order of prevalence.

Insufficient documentation

Insufficient documentation was the most prevalent finding. This documentation covered procedures and records of activities including evaluation and follow-up. Examples included the following: the failure to have a documented management system with policy, roles, and training requirements; the failure to document corrective actions taken to address an issue; and the failure to document the rationale for internal inspection frequencies.

There remains some confusion as to the level of documentation the NEB expects. As noted, documentation must be able to demonstrate the adequacy and effectiveness of the IMP. The best way to discover the level of documentation required is for a company to conduct self-audits as required by section 53 of the *OPR*. These self-audits should point out any deficiencies in documentation as well as any deficiencies in practices related to the IMP.

Lack of formal risk assessment

Another area where some companies have not been meeting NEB expectations is risk assessment. Companies will often focus on certain hazards to their pipeline system and fail to dedicate resources to address other hazards. There is a perception with some companies that they know the risks to their pipeline system and therefore do not need to conduct a formal documented risk assessment. This may be true. However, if companies use this knowledge to justify placing fewer resources into mitigating a particular hazard, they will need to demonstrate to the NEB the basis and validity of this decision. A formal risk assessment provides a company an increased understanding of the nature and potential consequences of the hazards to its pipeline integrity and, therefore, helps to determine when and if those hazards have been adequately mitigated. The type and rigor of the assessment to be carried out is best decided by the individual company.

Inadequate management of change

As stated previously, the NEB expects companies, as per the requirements of the *OPR* (section 6) and *CSA Z662* (clause 10.2.1.1), to develop and apply a MOC program. Changes that have the potential to affect pipeline system integrity can be initiated by the company or by external stakeholders. The findings of the six audits conducted revealed that companies generally have not managed changes appropriately or effectively. Companies had one of three shortcomings: 1) they have not developed a formal MOC program; 2) they have not addressed all types of changes in their MOC program; or 3) they have not consistently applied their MOC program. For instance, some companies had not updated their O&M procedures to reflect changes in regulations, industry standards, or operating practices. The audits also found that equipment changes (e.g., replacement or relocation) have not always been captured in the MOC program.

The MOC program must be able to assist a company in identifying or recognizing changes, to review the changes, and to approve or reject these changes. Once the changes have been implemented or mitigated, a company must make any

Copyright © 2002 by ASME

Downloaded From: https://proceedings.asmedigitalcollection.asme.org on 06/29/2019 Terms of Use: http://www.asme.org/about-asme/terms-of-use

appropriate changes to the IMP, such as condition monitoring activities and O&M procedures. The NEB expects that all changes affecting the integrity of the pipeline system are documented.

Inadequate evaluation of employee or contractor competency

Competent personnel are essential for the development and implementation of all the components of an IMP. These personnel include controllers who operate the pipeline system, contract welders who perform maintenance welding on piping, pilots who survey the pipeline right-of-way, and ILI vendors who "smart-pig" the pipelines and glean valuable information from the interpretation of massive data sets. The audit findings revealed that companies need to formalize employees' competency programs, establish criteria for contractor management (evaluation and selection), and develop a method to evaluate the adequacy and effectiveness of the competency programs.

Lack of evaluation of IMP adequacy and effectiveness

Section 53 of the *OPR* requires companies to conduct regular audits and inspections of their pipeline system. The audits found that all companies have not carried out an evaluation of the IMP. Self-audits, which are an integral component of an adequate and effective IMP, must be sufficiently rigorous to identify any gaps in the IMP. These include gaps in the structure, rationale, and implementation of the IMP. For self-audits to be effective there must be commitment from top management and buy-in from the company's employees. These audits provide management with an assurance that the IMP is working as it should be and allow it to correct any deficiencies before they result in incidents. Employees benefit from these audits because they are given an opportunity to provide feedback and to effect changes in their day-to-day activities to assure pipeline integrity and their personal safety.

CONCLUSION

The NEB has developed goal-oriented regulations mainly with a twofold purpose: 1) to promote safety and environmental protection and 2) to offer companies the flexibility to meet those goals appropriately based on the nature and scope of their businesses and operations and on the best available technology. To verify company compliance with the goal-oriented *OPR*, the NEB has implemented a management system audit program based on the principles of ISO 9000 and 14000 series of standards and a set of expected elements.

This paper has outlined the NEB's expectations for compliance with a goal-oriented regulation addressing pipeline integrity. The six audits conducted in 2001 have shown the value of management system audits in providing the NEB with a more holistic view of companies' programs for managing the integrity of their pipeline systems. As well, the audits have pointed out potentially systemic problems that companies must remedy across the organization and pipeline systems, not just specific projects.

One key challenge is for companies to maintain sufficient and appropriate documents and records. Such records would allow them to better assess any integrity threats on or to their pipeline systems, make well-informed and cost-effective decisions for monitoring and mitigating risks, and demonstrate due diligence and the adequacy and effectiveness of their systems and programs. For the NEB, the key challenges include maintaining an appropriate level of competency in the audit team, ensuring that the audits are consistent, and avoiding the trap of "glorified inspections" that finds faults on "trees" and misses the holes in the "forest".-

The NEB will continue to review, on a regular basis, its auditing tools following each audit and, if required, update any regulations, guidance notes, and expected elements. The NEB hopes regulated companies, as well as the Canadian public will see the auditing program as a "service" that it is providing to benefit the companies and their employees, the public, and the environment.

ACKNOWLEDGEMENTS

The authors would like to thank colleagues at the National Energy Board for their critical review of the paper and their constructive remarks.

REFERENCES

[1] *Onshore Pipeline Regulations, 1999*, SOR/99-294

[2] *Z662-99 Oil and Gas Pipeline Systems*, 1999, Canadian Standards Association, Etobicoke, Ontario

[3] *Standard 1160: Managing System Integrity for Hazardous Liquid Pipelines*, 2001, American Petroleum Institute, pp. 36-40

[4] http://www.neb-one.gc.ca/safety/spi/safetyinforequest_e.htm

Copyright © 2002 by ASME

Downloaded From: https://proceedings.asmedigitalcollection.asme.org on 06/29/2019 Terms of Use: http://www.asme.org/about-asme/terms-of-use